VARIABILITY OF FARM INCOMES:

SOME PRELIMINARY CROSS-SECTIONAL AND LONGITUDINAL ANALYSES

by

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Farmers, farm advisors, agricultural lenders, policy analysts and policymakers have all expressed concern about the variability of farm income. As would be expected, negative deviations in income have tended to receive considerably greater attention than positive deviations at both the individual farm and agricultural sector levels. Commonly attention is directed at current farm income relative to income in the preceding year or relative to what income was expected to be. Typically individuals use different concepts of income and may reach opposing conclusions with respect to the situation.

Stability in agriculture has often been indicated as one of the goals of agricultural policy. However, Gardner suggests that policymakers have been concerned primarily with income support rather than stability or risk management aspects. Even programs initiated for risk management purposes, such as crop insurance, have become subsidy programs. Baum and Harrington indicate that policy analysts have an interest in a better understanding of the interaction between risk and policy. Furthermore, we as agricultural economists have given limited attention to the risk effects of policy on farm firms and the effects of risk management by the farm firm on policy choices. Analyses have tended to focus on the optimal behavior of farmers in response to a specific program and to program changes rather than on producer behavior and behavioral modifications if the policy environment changes.

The objectives of this paper were modest initially and became more modest with implementation of Gramm-Rudman which eliminated the participation of Ken Baum and the Farm Costs and Returns Section of ERS. Hopefully this paper will raise some questions and stimulate further consideration of the interaction of government policy and variability of farm income. In the first section, the variability of prices and yields which contribute to differences in income variability among regions and types of farms, as well as income variability over time, are illustrated. Second, limited information on the cross-sectional income variation from the U.S. Department of

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Agriculture Farm Costs and Returns Survey (Johnson, Baum and Prescott) is presented. The third section turns to analysis of the longitudinal variation of different measures of income for 72 Indiana farms during the 1971-82 period. The final section briefly discusses some of the unanswered questions with respect to farm income variability and agricultural policy.

Some Differences in Income Variability

Variability of U.S. farm income is the result of the interaction of several domestic factors including agricultural output, product and input prices, general economic and agricultural policy as well as events in the rest of the world. As a simple indicator of income variability in agriculture, Kolhs computed year-to-year changes in revenue for the average acre of Indiana corn from 1914 to 1985. During that 71 year period, revenue increased by more than 20 percent over the preceding year 17 times (24 percent) and decreased by more than 20 percent 8 times (11 percent). The year-to-year change in revenue was a plus 10 to 20 percent in 10 years (14 percent) and a negative 10 to 20 percent in 11 years (15.5 percent). Although the revenue change was less than 10 percent plus or minus in 25 years (35 percent), the average yearly revenue change was plus or minus 19 percent. Combining effects of yield, price and changes in the general price level, this simple measure provides a vivid picture of variability in agriculture.

Crop and livestock production are biological processes subject to the effects of numerous random variables and this production variability varies geographically. For example, the coefficient of variation for wheat production ranges from 14.0 percent under irrigated conditions in the Colombia River Basin to 42.1 percent for Brown County, Nebraska and 61.1 percent for Southwest Oklahoma after the effects of yield trend have been removed (Sonka and Patrick). Although data are not readily available, it is to be expected that there are also geographic differences in the variability of measures of livestock productivity. In addition to the geographic differences in variability, there are also differences in crop yield variability over time. For example, the coefficient of variation for the trend adjusted Illinois corn yield was over 33 percent for the 1930s, more than twice as large as the 16 percent coefficient of variation for the 1960s (Sonka and Patrick).

Real prices and price variability have also changed over time. The annual average corn price received by Indiana farmers, in 1985 dollars, increased from $3.26 per bushel with a coefficient of variation of 10.3 percent for 1960-72 to an average of $3.68 with a coefficient of variation of 25.9 percent for the 1973-85 period. For the same periods the real average price of soybeans increased from $7.49 to $9.20 per bushel and the coefficient of variation increased from 9.2 to 26.8 percent. Hogs and beef cattle also experienced substantial increases in the coefficients of variation of real prices. For hog prices the coefficient of variation went from 13.4 to 23.8 percent and the increase was from 5.9 to 19.2 percent for beef, although the average real price of beef cattle

declined slightly. The coefficient of variation for milk, the most stable commodity, increased slightly from 7.5 to 8.4 percent. Turkeys were the only major Indiana commodity to show a decline in real price variability from 12.5 to 11.8 percent in the periods considered and this decrease was small (Patrick, 1986a).

Variability of production and commodity prices are major factors affecting the variability of incomes in agriculture.[1] As Table 1 shows, income variability differs substantially among regions and types of farms during the 1965-79 period. The relative stability of milk price is reflected in the lower coefficients of variation for dairies relative to other farms in Michigan and Indiana. The generally greater variability of physical production under dryland conditions, like Kansas, is reflected in the relatively high coefficient of variation of labor income. Even within a limited geographic area like Illinois there are differences in the level and variability of labor incomes as indicated by the northern and southern groupings of grain and hog farms. The incomes presented in Table 1 are an average over time of the average annual incomes of substantial numbers of farms and thus are likely to substantially underestimate the variability of individual farm incomes.

Table 1. Variability of Real Farm Labor Income, 1965-79 for Selected States and Types of Farms (a)

State and type of farm	Mean income	Standard deviation	Coefficient of variation
Kansas farm	22,737	26,848	118.7
Michigan			
Specialized dairy	19,801	15,144	76.5
All farms	19,371	17,347	89.6
Illinois			
Northern grain	34,221	27,310	79.8
Southern grain	29,400	13,969	52.8
Northern hog	39,580	38,614	97.6
Southern hog	37,208	22,979	61.8
Southern beef	12,502	31,022	248.1
Indiana (per operator)			
Hog	53,472	36,901	69.0
Dairy	27,622	9,645	34.9
Crop	43,793	34,796	79.5
Crop-Hog	50,833	38,220	75.2
State	45,706	31,395	68.7

Source: Adapted from Sonka and Patrick (1984).

(a) Derived from annual farm record summaries in the selected states. Concepts of labor income (or returns to labor and management) differ among states, but are consistent over time for a state. Incomes have been inflated to 1985 dollars by the index of prices paid for commodities, interest, taxes and wages.

Table 2 shows the change in the level and variability of average real labor incomes by type of Indiana farms for the 1960-72 and 1973-83 periods. Farms are classified as crop farms if more than 60 percent of the productive manwork units are in crops and as livestock farms if more than 60 percent of the productive manwork units are from livestock. For hog and dairy farms, more than two-thirds of the productive manwork units are from those enterprises. The total number of farms and number of farms in each category varies from year-to-year.

Table 2. Average Real Labor Income Per Operator in 1985 Dollars and Coefficients of Variation for Selected Types of Indiana Farms, 1960-83. (a)

Type of Farm	1960-72		1973-83		1960-83	
	Average ($)	C.V. (%)	Average ($)	C.V. (%)	Average ($)	C.V. (%)
Hog	32033	73.2	48847	93.6	39379	89.6
Dairy	19182	42.3	22593	92.9	20746	72.9
Crop	23308	52.9	43491	97.8	32559	95.7
Crop-Hog	32307	88.4	38392	96.3	35773	94.6
All farms	25829	55.8	42353	93.8	33403	88.0

Source: Patrick (1986b).

(a) Purdue University Cooperative Extension Service, based on "Farm Business Summary - State Summary." Converted to 1985 dollars using the GNP Implicit Price Deflator.

Agricultural policy underwent modifications in each of the periods, but the 1960-72 period can be generally characterized by more government control and intervention than the more market-oriented policies of the 1973-83 period. Average real labor incomes were higher and more variable for all types of farms in the latter period.[2] Real average labor incomes were up 86.6 percent for crop farms, 52.5 percent for hog farms, 18.8 percent for crop-hog farms and 17.8 percent for dairy farms. The increased variability of labor income was especially marked for the dairy and crop farms. Impacts of the more market oriented policies of the 1970s were clearly not limited to crop farms. The increase in variability of dairy farms also reflects the change in dairy policy and declining real price of milk since the 1979 peak. Although hog farms generally had high incomes in 1982, after low incomes in 1979 and 1981, incomes for the other types of farms have been below the 1960-83 trends for 1980 and later years. The Purdue recordkeeping

project was discontinued after 1983, but it is apparent that real incomes have continued to be generally low.

Cross-Sectional Income Variability

The Farm Costs and Returns Survey conducted by USDA provides information concerning the financial profile and condition of farm operators as of January 1, 1985 (Johnson, Baum and Prescott). This is a multiframe probability-based survey with about 17,000 respondents. Information provided by respondents was used to develop coordinated cash flow and balance sheets for farm operators which could be analyzed by reported debts and assets, farm size by sales class, type of farm and geographic region.

The coordinated cash flow and balance sheet information provided by farm operators begins with total crop and livestock sales plus other farm income (custom work, Government payments, etc.) to equal gross income from farm operations. Cash operating expenses, including interest paid, were substracted to yield the net cash income from the farm operation. Nonfarm income was added to obtain the income from farm and nonfarm sources. In addition, respondents provided information on farm assets and debts. Thus, producer-provided information can be used to derive the debt/asset position and cash income.

Secondary information was used to derive estimates of a family living allowance. The family living allowance was estimated as the median family income for nonmetropolitan counties reduced by the implicit net rental value of farm dwellings and income taxes. The housing adjustment was made because the farm operator's dwelling is typically on the farm. The income tax adjustment was made because farms with cash flow shortfalls would usually have losses for income tax purposes and reduced tax liabilities. This assumption may not be warranted for some of the higher income farms. For the average farm family the living allowance was estimated at $12,950 (Johnson, Baum and Prescott, p.6).

Debt principal repayments were estimated at 8.6 percent of outstanding debt. This assumes that one-half of the debt is amortized over a 20 year period and the rest is amortized over 5 years with an interest rate of about 11.75 percent. Operating loan interest would be included in the interest paid.

The cash balance (surplus or shortfall) represents the estimated net cash flow of the combination of the farm operation and off-farm income. A surplus cash balance would be available to offset depreciation and alternative purposes. A shortfall represents the deficit occurring. Estimates of the proportion of farms with a negative cash flow were determined within the various categories.

Table 3 summarizes the average estimated cash balance and percent of farms with a zero or negative cash balance by debt/asset ratio and type of farm. Of the farms with debt/asset ratios of 40

percent or less, only the general crop and other livestock types of farms had negative cash balance. However, it was estimated that 48 percent of the farms in the field crops and general livestock categories and 47 percent of the fruit and nut farms had negative cash balances. At the other extreme, of the technically insolvent farms (debt/asset ratios of over 100 percent), the nursery and greenhouse farms, as well as the vegetables and melon farm category had positive cash flow balances on the average. Some 45 percent of the technically insolvent field crop farms had a positive cash balance. Only in the other livestock category did 100 percent have negative cash balances.

Table 3. Estimated Cash Balance and Percent of Farms with Negative or Zero Cash Balance by Type of Farm and Debt/Asset Ratio, 1984.

Type of Farm	Debt/Asset Ratio				
	0-40%	40-70%	70-100%	over 100%	All
Cash grain	18,410 35	-4,626 56	-28,840 69	-22,768 68	10,668 41
Fields crops	7,674 48	-8,301 52	-30,359 89	-15,123 55	5,117 50
Vegetables and melons	27,620 42	-2,513 61	-3,816 84	87,742 60	23,971 47
Fruit and nuts	12,411 47	-46,893 69	-77,810 70	-81,378 84	2,905 51
Nursery and greenhouses	20,675 40	43,871 25	25,118 4	16,815 54	22,124 39
General crop	-16,255 70	-33,029 63	-40,351 83	-90,040 82	-20,742 70
General livestock	6,811 48	-23,645 69	-20,962 77	-41,537 83	2,000 52
Dairy	11,214 42	-11,262 66	-31,025 85	-38,253 84	1,712 52
Poultry and eggs	44,778 23	26,058 45	40,944 55	-61,565 77	38,552 31
Other livestock	-1,990 53	-14,211 57	-55,197 95	-29,207 100	-4,519 55

Source : Johnson, Baum and Prescott, Appendix table 6.

The underlying relationship is generally as one would hypothesize -- categories of farms with higher proportions of debt have larger percentages of farms with zero or negative cash balances. There is considerable variability around this general tendency. Very substantial proportions of farms with less than 40 percent debt, those characterized as "generally few financial problems and very strong net worth", do have negative cash balances indicating difficulties in making principal payments. On the other hand, many insolvent farms have positive cash balances.

Table 4 indicates the estimated cash balances and percent of farms with zero or negative cash balances by sales class and debt/asset ratio. Again the general tendencies are as one would hypothesize. The absolute values of cash balances increase as sales increase. Also, the estimated cash balances are positive for all sales categories for farms with less than 40 percent debt and cash balances tend to become negative as the debt/asset ratio increases. However, the averages again hide significant variation within each category. Well over half of the farms with less than $40,000 of sales have negative cash balances even when nonfarm income is considered. Farms with less than $40,000 in sales represent about two-thirds of the farms with negative cash balances. However, although farms with less than $40,000 in sales represent over 60 percent of the U.S. farms as defined for survey purposes, they hold less than 17 percent of the debt. In contrast, although the farms with over $500,000 in sales represent 1.8 percent of the farms, they hold almost 17 percent of the total debt (Johnson, Baum and Prescott).[3]

Table 4. Estimated Cash Balances and Percent of Farms with Negative or Zero Cash Balance by Sales Class and Debt/Asset Ratio, 1984.

Sales per	Debt/Asset Ratio				
Farm	0-40%	40-70%	70-100%	over 100%	All
under $10,000	1,941	-768	-14,926	-14,000	1,318
	52	48	73	78	52
10-19,999	1,088	-6,452	-25,646	-17,318	-988
	53	60	87	76	56
20-39,999	8,288	-21,098	-20,956	-28,834	2,496
	53	92	73	91	60
40-99,999	5,266	-23,938	-31,471	-33,933	-3,647
	38	70	85	76	48
100-249,999	22,466	-13,468	-37,020	-45,293	7,401
	29	57	71	69	40
250-499,999	42,967	-7,418	-35,866	-30,372	19,774
	28	47	69	60	38
over $500,000	133,777	-7,091	62,100	-166,365	66,923
	34	50	47	53	40

Source: Johnson, Baum and Prescott, Appendix table 5.

Cross-sectional information is very valuable in providing an overview of the situation at a given point in time. However, without a reference point, it is difficult to assess what the information implies. The usefulness of the information was enhanced by estimates of the percentage of farms with zero or negative cash balances. Usefulness would have been further enhanced if the additional information on skewness and other characteristics which have been analyzed by the Farm Costs and Returns Section could have been presented at this meeting. We will look forward to that analysis, results of the survey on 1986 conditions and analysis of the changes which have occurred.

Longitudinal Analysis of Income Variability

Longitudinal data from a group of the Purdue recordkeeping cooperators provides a basis for analysis of farm income over time. Summary information is available for 72 farms which participated in the record project for the entire 1971-82 period. The record keeping project was originally designed in the 1930s for comparative business analysis, thus information is not available on the financial aspects of the farm firms such as debt/asset ratio and interest paid. Data are based on the entire farm unit operated by a cooperator and include the investment, income, expenses and earnings of both the operator and owner when the unit includes rented land. Nonfarm labor earnings of the operator are also included if off-farm work does not exceed 100 days in a year.

The farms in the recordkeeping project are not representative of all farms in Indiana. All are commercial farms with sales in excess of $40,000. The recordkeeping farms are somewhat larger and generally are operated somewhat more efficiently than other commercial farms. Although the 72 farms in this analysis are not representative, they are not atypical of the commercial farms in Indiana and the changes which occurred over the 1971-82 period. For purposes of this analysis, all monetary values are expressed in 1985 dollars using the GNP implicit price deflator.

During the 1971 to 1982 period, the average real capital investment per farm operation increased from $573 to $1,351 thousand and cash receipts increased from $188 to $308 thousand. Capital investment in 1982 was about 15 percent below the peak of 1980. Land was consistently valued at about 75 percent of market prices thoughout the period. The average farm operated a total of 473 crop acres in 1971 and 651 crop acres in 1982. The proportion of rented land was almost constant at 45 percent, although the absolute acreage of rented land increased from 213 to 299 acres per farm operation. Four farms owned all of the land operated over the period and one operator owned no land. The average labor force also increased from 1.93 to 2.24 man-equivalents per farm.

Several concepts of income are utilized in the following tabulations. Cash receipts include sales of crops, livestock, livestock products, machinery and equipment, buildings and improvements. Government payments, rents received, custom work

done, limited off-farm work and other cash receipts are included. Cash expenditures include the cash production expenses (excluding interest payments) and purchases of capital items such as livestock, machinery and equipment, buildings and improvements. Net cash income is simply the difference between cash receipts and expenditures. A farm operation with exactly the same production income and expenses in two years could show a large negative net cash income if a tractor were purchased in one year and a large positive net cash income if the tractor were sold the following year. Sales of capital items were generally small over the 1971-82 period.

Net farm income is equal to the net cash income plus (or minus) the change in inventory value during the year. Inventories of livestock, crops and supplies are valued at market prices at the beginning and end of the year, but the value of land is held constant within the year. Thus a change in corn prices between the beginning and end of the year could result in an inventory adjustment, but a change in land values would not. The values of machinery, equipment, buildings and other improvements are taken from the depreciation schedules. Depreciation for tax purposes would be a negative inventory adjustment. Capital purchases and sales are essentially netted out in farm income.

Land purchases or sales and land price adjustments are assumed to occur between years. If land is purchased during the year and the operator receives the crop output, the land would appear on the January 1 inventory. If the crop production were not received by the operator, then the land would not appear on inventory until the following year. Adjustments in land values are made between the closing inventory of one year and the initial inventory of the following year.

Labor income is an estimate of the return to labor and management of the owner-operator or to both the owner and operator when land is rented. It is the farm income discussed previously, minus a 5 percent interest charge on the total capital investment of the farm operation. The labor income per farm is divided by the number of operators to obtain the labor income per operator. Operators who work less than full-time on the farm are coded as the proportion of a year worked on the farm. Thus the labor income per operator effectively represents the labor income per operator year.

The rate of return on investment is an estimate of the return to the total investment in the farm operation, not the return on operator equity. The rate of return on investment was calculated as the farm income minus a labor and management charge of $1,500 per month of operator time, divided by the total capital investment. The estimated rate of return on investment does not include any change in land values because, as noted previously, land values are held constant within a year.

Table 5 summarizes the means and mean coefficients of variation of the selected real income measures by type of farm. To be

classified as a specific type of farm, an average of 50 percent or more of the annual cash receipts in the 1971-82 period came from a specific enterprise. A coefficient of variation was computed for each farm for the income measures over the 12-year period. The mean coefficients of variation, the second row for each type of farm, are the averages of these measures of variability over time. There are a reasonable number of farms in each farm type classifications except for the four beef farms. The variability of income on the beef farms, corroborated by the Illinois beef farm information in Table 1, suggest that beef farms should not be combined with other types of farms.

Table 5. 1971-82 Means and Mean Coefficients of Variation (a) for Selected Real Income Measures (b) by Type of Farm - 72 Indiana Farms.

Type and Number of Farms(c)	Cash Receipts ($000)	Cash Expenditures ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Rate of Return (%)
Crop	242.7	168.8	73.9	103.9	43.7	36.2	7.8
n=16	25.4	29.0	69.7	60.2	232.3	279.0	97.6
Hog	312.4	229.7	82.7	123.0	70.8	52.2	8.7
n=15	21.3	24.3	77.4	62.6	174.7	222.8	133.6
Beef	450.0	416.7	32.6	71.2	6.7	7.6	4.6
n=4	16.9	21.5	269.8	95.0	4555.5	4703.0	174.2
Dairy	235.2	189.6	45.6	87.1	45.0	38.3	7.3
n=26	24.7	32.6	429.9	55.7	249.2	156.4	94.6
Mixed	384.6	295.4	89.2	147.2	74.1	45.2	8.6
n=11	25.0	28.1	94.3	53.2	132.5	140.4	78.3

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) To be classified as a specific type of farm, an average of 50 percent or more of annual cash receipts in the 1971-82 period were from the specified enterprise.

The variability of cash expenditures is greater than for cash receipts for all five types of farms, probably reflecting the effect of purchases of capital items such as land and machinery. Part of the relatively low variability in both cash receipts and expenditures would be due to the change in farm size generally experienced over the period. The variability of net cash income was considerably higher than the variability of receipts and expenditures, and was also greater than the variability of farm income when inventory changes are taken into account for all types

of farms. There are substantial differences in the level of farm income per operation among types of farms with mixed farms having net farm income twice that of beef farms. However, except for the more variable beef farms, there is little difference in the mean coefficients of variability of net farm income among farm types.

The residual measures of income, such as labor income per farm, labor income per operator and rate of return on investment, are considerably more variable than the more aggregate income measures. Like farm level prices as compared with retail prices, the relative variability becomes greater as the denominator of the relationship becomes smaller. There are also differences in the level and variability of labor income per operator. Excluding beef producers, the crop farmers have the lowest and most variable labor incomes per operator. The coefficient of variation is about twice the mixed farm operations and almost 80 percent greater than dairy farms.[4] The coefficients of variation indicate that labor income per operator varied greatly on the same farm operations over time.

Enterprises with greater variability would be expected to have higher average returns as adjustments occur toward equilibrium. For the period analyzed there is little relationship between the level and variability of returns. The 1970s were a period of major change in agriculture, thus there may have been little movement toward equilibrium. Furthermore, much of the return in agriculture accrued as capital gains and the year-to-year increases in land values are not reflected in the income measures analyzed.

The range of mean rates of return to total investment, except for the beef operations, was from 7.3 to 8.7 percent. Although the differences among types of farms were relatively small, there was a considerable variation within farm types and for the same farm operations over time. For the overall period, the average rate of return on individual hog farms ranged from a low of -.7 percent to a maximum of 17.0 percent. The coefficients of variation for the rate of return on individual farms over the period varied from 4.2 to 597.7 percent. The ranges of variation in returns and coefficients of variation for the other types of farms analyzed were smaller than for the hog farms.

Table 6 summarizes the means and mean coefficients for variation for the selected income measures by size of the farm operation, measured as gross receipts. The tendency for the variability of income to be higher for the residual income measures discussed for Table 5 can also be observed for Table 6. The average labor income per operator and the percent rate of return on investment increase sharply as gross receipts of the farm operations increase. For farm operations with over $400,000 in average gross receipts, labor income per operator is more than 3 times the labor income for operations in the under $200,000 gross receipts category, and the rate of return on investment is 50 percent higher.

Table 6. 1971-82 Means and Mean Coefficient of Variation (a) for Selected Real Income Measures (b) by Gross Farm Receipts, 72 Indiana Farms.

Gross Receipts(c) (n=number)	Cash Receipts ($000)	Cash Expenses ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Return on Investment (%)
$200,000	132.0	96.2	35.9	50.9	23.6	22.3	6.4
or less	22.3	30.6	77.3	58.7	198.1	260.0	129.5
n=28							
$200-$400,000	279.8	220.4	59.4	100.3	45.8	41.2	7.9
n=28	23.5	29.0	412.6	62.5	661.0	698.3	98.9
over $400,000	573.9	445.6	128.4	215.2	114.3	69.3	9.8
n=16	26.8	25.2	115.8	57.8	527.7	353.2	74.2

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) Gross receipts classification is based on the average annual cash receipts in 1985 dollars for the 1971-82 period.

The relative variability of net farm income is almost constant across the gross receipts groups, but the labor incomes per farm and per operator are more variable on the two larger categories of farm operations. In contrast to labor incomes, the variability of the rate of return on investment decreases as the gross farm receipts increase. These relationships are associated with the residual nature of the income calculations. The $1,500 per month charge for operator labor takes a larger proportion of net farm income on the smaller farm operations, resulting in greater variability of the rate of return on investment. On larger farm operations, the charge for operator labor is smaller relative to the net farm income resulting in less variability in return on investment. The situation is reversed for labor incomes when a fixed interest charge is made for the use of capital.

Tables 7, 8 and 9 summarize other tabulations on the level and variability of incomes by other measures of farm size. Table 7 classifies farms in terms of the average number of tillable acres operated. In general, the results are very similar to those obtained when farm operations were grouped on the basis of gross receipts. Farm operations in the middle size category, 300 to 600 tillable acres, have greater variability of net cash income and labor income per farm and per operator. In Table 8 the farm operations are classified by average real capital investment and Table 9 uses the average size of the labor force.

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Table 7. 1971-82 Means and Mean Coefficients of Variation (a) for Selected Real Income Measure (b) by Average Tillable Acres, 72 Indiana Farms.

Size of Farm (c) tillable acres (n-number)	Cash Receipts ($000)	Cash Expenditures ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Rate of Return (%)
Less than 300	148.3	115.6	32.7	52.1	26.3	22.9	6.4
n=26	20.6	28.6	91.8	59.2	200.1	267.2	128.0
300-600 acres	275.4	210.8	64.6	102.3	49.8	40.0	8.2
n=30	25.1	29.7	378.8	60.7	616.3	645.1	100.8
over 600 acres	537.3	416.4	120.9	203.1	99.8	68.2	9.2
n=16	26.5	27.3	113.7	59.8	550.5	370.5	77.0

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) Size of farm was based on the average tillable acres for the 1971-82 period.

Table 8. 1971-82 Means and Mean Coefficient for Variation (a) of Selected Real Income Measures (b) by Average Total Capital - 72 Indiana Farms.

Ave. Capital Investment(c) (n=number)	Cash Receipts ($000)	Cash Expenditures ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Rate of Return (%)
Less than	121.7	89.6	32.0	43.7	22.1	21.1	6.2
$600,000	20.9	28.8	70.0	56.3	180.3	259.2	132.5
n=20							
$600,000 to	31.1	81.3	49.8	83.1	40.1	38.4	7.8
$1,200,000	24.2	31.3	398.9	62.0	652.0	704.9	106.3
n=27							
over $1,200,000	481.6	372.2	109.4	182.4	90.0	57.1	8.9
n=25	25.6	26.0	136.0	60.7	451.5	320.5	82.6

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) Classification by capital investment is based on the average capital investment, in 1985 dollars, for the 1971-82 period.

Table 9. 1971-82 Means and Mean Coefficients of Variation (a) for Selected Real Income Measures by Size of Labor Force, 72 Indiana Farms 1971-82.

Size of Labor Force (n=number)	Cash Receipts ($000)	Cash Expenditures ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Rate of Return (%)
Less than 1.5	152.5	116.5	36.0	49.5	19.6	21.3	5.9
man-equivalents	21.0	27.6	94.4	66.2	703.9	927.8	146.4
(n=22)							
1.5 to 2.5	268.6	199.9	68.7	107.1	52.7	40.6	8.4
man-equivalents	24.2	30.3	96.0	55.7	174.7	181.2	88.5
(n=31)							
more than 2.5	475.3	380.6	95.7	172.0	89.9	61.0	8.8
man-equivalents	26.4	27.6	553.6	59.8	610.3	326.4	85.2
(n=19)							

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) Classification is based on the average labor force for the 1971-82 period.

The tendency for the rate of return on total investment to be higher and less variable on the larger farms can be observed for all of the measures of size used. Although net farm income increases with the size measures used for tabulation, there is very little difference in the relative variability with size. The mean labor income per operator also increases with farm size, but the variability of labor income per operator is not entirely consistent. For size measured in terms of gross receipts, tillable acres, and average total investment, the middle size groups have the greatest relative variability. However, when size is measured by the labor force, the smaller farms (those with less than 1.5 man-equivalents of labor) have the greatest variability.

Table 10 summarizes results when the farm operations are classified by the average percentage of land rented. No distinction is made whether rental is on a cash or share basis. Furthermore, the income measures refer to the entire farm operation, not the operator's portion alone. Cash income, net farm income, labor income per operator and rate of return on investment all increase as the percent of land rented increases. There is little difference in the relative variability of net farm income with changes in the percent of land rented. This is similar to the results obtained when size factors were used for classification purposes. The variability of the rate of return on investment decreases slightly as the percent of land rented increases, but there is no particular pattern with respect to labor income per operator.

Table 10. Mean and Mean Coefficients of Variation (a) for Selected Real Income Measures (b) by Percent of Land Rented, 72 Indiana Farms 1971-82.

Percent of land rented (c) (n=number)	Cash Receipts ($000)	Cash Expenditures ($000)	Cash Income ($000)	Farm Income ($000)	Labor Income per Farm ($000)	Labor Income per Oper. ($000)	Rate of Return (%)
Less than 33.3%	288.6	236.6	52.1	96.9	44.7	33.8	7.0
n=27	21.0	29.0	159.4	64.0	488.0	432.6	122.7
33.3 to 66.6%	260.9	199.9	61.0	100.1	48.3	39.9	7.9
n=27	25.6	32.1	365.5	57.8	157.4	157.6	95.0
over 66.7%	326.4	233.7	92.7	131.0	70.1	49.9	8.6
n=18	25.2	23.5	77.7	57.1	837.3	905.7	94.7

(a) Coefficients of variation are in the second line and are expressed as percentages.

(b) Values are expressed in 1985 values using the GNP Implicit Price Deflator.

(c) Classification based on the average annual percent of land rented for the 1971-82 period.

The available information does not permit the farm operations to be classified by financial position, but effects of differences in financial condition of firms can be simulated by computing what farm income would have been at different levels of debt. The farm income in previous tables excludes all interest payments and includes the returns to the entire farm operation. Thus it can be interpreted as representing the full equity owner-operator farm. Debt/asset ratios of 25, 50 and 75 percent are assumed and the net farm incomes per farm per year for the 1971-82 period are calculated assuming a 10 percent rate of interest. No amortization of the debt is considered in determining the net farm income.

Table 11 indicates the mean, minimum and maximum average net farm income under different debt/asset ratios. The mean, minimum and maximum coefficients of variation for incomes per farm as also presented. None of the 72 farms have negative net farm incomes at the 0 and 25 percent debt/asset ratios. The mean coefficient of variation of net farm income increases sharply between 25 and 50 percent debt and increases again when the debt/asset ratio increases to 75 percent. This increase in relative variability is the result of the decline in the mean income because the standard deviation of income remains constant. However, it does demonstrate the greater variability of net income associated with higher levels of debt. The probabilities of negative net farm incomes and the associated cash flow difficulties are much greater as the debt/asset ratio increases.

Table 11. Effects of Alternative Debt/Asset Ratios on Annual Net Income per Farm 1971-82 (a) and Variability of Income for 72 Indiana Farms.

	Debt/Asset Ratio (percent debt)			
	0	25	50	75
	Annual Net Income per Farm in Thousands of Dollars			
Mean	106.6	79.5	52.4	25.3
Minimum	18.0	10.0	-13.1	-63.8
Maximum	425.4	365.7	306.1	246.5
	Coefficient of Variation of Income per Farm 1971-82 (%)			
Mean	60.0	89.7	451.3	660.4
Minimum	25.3	28.7	34.4	44.9
Maximum	133.3	384.1	11002.8	11641.8

(a) Incomes are expressed in 1985 dollars using GNP Implicit Price Deflator.

Table 12 indicates the mean labor income per operator and rate of return on investment by year for the 1971-82 period with indications of variability. The table suggests that there is considerable income variability among farms in any given year. Only in 1972 and 1973 did all of the 72 farms analyzed have positive labor incomes. Some rates of return on investment (excluding increases in land values) were negative in all of the years except 1973.

Table 12. Mean Labor Income per Operator (a) and Rate of Return on Capital Investment with Indications of Variation for 72 Indiana Farms, 1971-82.

	Labor Income/Operator ($000)				Rate of Return (%)			
	Mean	C.V.	Min.	Max.	Mean	C.V.	Min.	Max.
1971	28.9	194.2	-34.8	118.1	5.2	94.9	-9.2	16.6
1972	49.2	64.9	.8	143.2	10.6	56.3	-9.5	24.0
1973	111.0	89.5	14.2	541.4	20.2	46.2	3.1	38.7
1974	26.5	215.0	-142.5	255.6	6.9	121.5	-12.8	38.5
1975	50.9	136.2	-72.4	323.7	8.1	93.8	-7.3	31.8
1976	41.3	118.1	-83.0	214.7	7.7	65.6	-2.2	21.4
1977	19.0	253.5	-151.0	221.2	5.5	89.6	-5.3	23.3
1978	52.1	134.9	-52.2	481.2	8.2	50.6	-0.1	17.5
1979	72.5	241.7	-59.1	1436.9	8.0	63.9	-4.3	21.8
1980	35.4	160.0	-111.1	263.7	6.5	64.6	-4.2	16.4
1981	-19.4	266.7	-310.7	103.2	1.4	251.2	-5.3	11.6
1982	18.4	279.3	-85.8	293.9	4.7	100.4	-6.7	20.9

(a) Values are expressed in 1985 values using GNP Implicit Price Deflator.

These farms would generally be considered successful, yet there was great variation in their performance within years and over time. For example, between 1971 and 1983 the mean geometric rate of growth of total capital in 1985 dollars (including the change in land values) was 7.0 percent annually, but the growth rate ranged from -0.5 to 19.0 percent on the farms analyzed. This suggests that many of the observed differences in incomes of individual farms persisted over time.

Concluding Comments

The tables presented in the preceding sections suggest that there is considerable income variability in agriculture. There are differences in the variability of farm income associated with geographic location, type of farm, size of farm, financial position of the firm and time period considered. Furthermore, the variability within a specific group or classification of farms is often greater than the differences among groups. There is tremendous variability among farms of a given size type and financial condition in a specified geographic area and time period. Often we tend to forget the simple fact that about one-half of the farm operators are below average and this has major impacts on returns.

There are many different concepts of income. Gross farm receipts, net farm income, cash income available for debt servicing, labor income, return on investment, taxable income and household income are some of the different concepts of income. Each concept

may be appropriate for a particular purpose. The relative variability is generally greater for the more residual measures of income. Gross farm income is generally less variable than the net farm income or income available for debt servicing. Discussions of changes in farm receipts or gross farm income underestimate the variability faced by farmers in meeting loan payments and family living expenses. Variability can also be expressed as the range, variance and related measures, semi-variance or the probability of income below a specified level. There does not appear to be a "best" way of describing fluctuations. Both the concept of income and the measure of variability used should be appropriate for the question at issue.

Measurement of variability has commonly been on an annual basis, but longer time periods could be more relevant. In come instances, consideration of wealth or net worth may be important. For example, if capital gains (or losses) are significant in economic decision-making then these should be incorporated into the concept of income considered. Annual net incomes from farm operations were of little concern to many farmers when land values were increasing rapidly. In contrast, income available for debt servicing and cash flow variability are of paramount concern for many farmers today.

Income variability in agriculture is the result of many factors. Economic and agricultural policy may have impacts on this variability but there impacts may be extremely difficult to identify and measure. Even if policy effects can be separated from other influences, the policy effect may be a composite of several programs acting in opposite directions. We have also become more aware of policy induced risk. Making the links between policy and variability will be difficult.

Low observed variability does not imply that there is no problem with variability (IAC). Individual producers adjust to risk and uncertainty, and they respond to risk in a variety of ways. Production, marketing and financial responses are typically combined in risk management. These responses are designed to reduce variability and protect against the adverse consequences of unfavorable events. Low observed variability of income may reflect effective risk management, not the absence of a variability problem. Substantial costs may be involved in this risk management.

Income variability per se is not necessarily bad. If income fluctuations are planned or anticipated, negative influences may be minimal or nonexistent. A substantial number of farmers spend significant amounts of time in year-end tax planning and management. Although their intent is to smooth taxable income and reduce tax liabilities, wide swings in other measures of observed income often result.

The unanticipated variability of income commonly has consequences which were not foreseen. Many producers want protection from the adverse effects of the negative variations in

income, but no restrictions on the top side of positive variations. Farmers would like agricultural policy to serve as a stop-loss order, but to let their profits run.

One of the rationales for farm policy is to reduce or moderate variations in farm income. Costs are involved in reducing income variability in agriculture. These costs are often borne by individual farmers, but some are borne by society. We should not necessarily assume that costs of risk management will be reduced by government intervention and policy. The interactions of policy and risk management is a challenging area of needed research.

Footnotes

1. Myers and Runge conclude that much of the instability of the corn market in the 1970s and early 1980s can be attributed to the demand side of the market.

2. Barry and Barnard also encountered substantial increases in the level and variability of net farm income per PCA Districts comparing 1955-69 with 1970-83. The aggregate coefficient of variation almost tripled for the U.S. between periods and net farm income almost doubled.

3. The 54.4 percent of the farms of under $40,000 in sales with negative cash flows (almost 34 percent of all farms) hold less than 10 percent of the total U.S. operator debt. At the other extreme, the 40 percent of farms of over $500,000 in sales with negative cash flows (.72 percent of all farms) hold almost 10 percent of U.S. operator debt (Jolly et al.).

4. The dairy farms included in this longitudinal analysis have an average labor income per operator almost 50 percent higher than the average of all dairy farms in the recordkeeping project for the 1971-82 period. In contrast, the crop farmers are about 20 percent below the average of all crop farmers in the period. There is essentially no difference between the hog and mixed farms in the longitudinal analysis and the larger group of cooperators.

References

Barry, Peter J. and Freddie L. Barnard, "Interaction Effects on Rural Financial Intermediaries of Financial Stress and Deregulation", American Journal of Agriculture Economics, Vol. 67, No. 5, December 1985, pp. 1191-1195.

Baum, Kenneth and David Harrington, "Research, Risk and Agricultural Policy: Some Suggestions from Within the Fire," Risk Management Strategies for Agricultural Production Firms: Perspectives and Research Issues, Department of Agricultural Economics, Oklahoma State University, AE-8350, May, 1983, pp. 12-28.

Gardner, Bruce, "Policy Uses of Risk Management Risk," Risk Analysis for Production Firms: Concepts, Information Requirements and Policy Issues, Department of Agricultural Economics, Michigan State University, Staff Paper 85-85, November 1985, pp. 165-84.

Industries Assistance Commission, Rural Income Fluctuations, Industries Assistance Commission Report No. 161, Canberra, Australian Government Publishing Service, 1978.

Johnson, Jim, Kenneth Baum and Richard Prescott, "Financial Characteristics of U.S. Farms, January 1, 1985," National Economics Division, Economic Research Service, U.S. Department of Agriculture, Agriculture Information Bulletin No. 495, July 1985.

Jolly, Robert W., Arnold Paulsen, James D. Johnson, Kenneth H. Baum and Richard Prescott, "Incidence, Intensity and Duration of Financial Stress among Farm Firms," American Journal of Agricultural Economics, Vol. 67, No. 5, December 1985, pp. 1108-1115.

Kolhs, Richard L., "What Will Next Year Be Like? Different!", Department of Agricultural Economics, Purdue University, mimeo March 4, 1986.

Myers, Robert J. and C. Ford Runge, "The Relative Contribution of Supply and Demand to Instability in the U.S. Corn Market," North Central Journal of Agricultural Economics, Vol. 7, No. 1, January 1985, pp. 70-78.

Patrick, George F., "Risk Management in Agriculture (Part II) - Variability and Risk in Indiana Agriculture," Purdue University Cooperative Extension Service, EC-648, in press, 1986a.

Patrick, George F., "Risk Management in Agriculture (Part III) - Risk Management Strategies," Purdue University Cooperative Extension Service, EC-649, in press, 1986b.

Purdue University Cooperative Extension Service, "Farm Business Summary - State Summary," Purdue University Cooperative Extension Service, EC-253, various years.

Sonka, Steven T. and George F. Patrick, "Risk Management and Decision Making in Agricultural Firms," in Peter J. Barry (ed.) Risk Management in Agriculture, Ames: Iowa State University Press, 1984.